Reconsidering Priestley's Defense of Phlogiston

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Building on John Norton's (2003) "material theory of induction", I contend that studies of the use of analogy in experiment can provide historical and philosophical insight into the process of discovery and invention. In particular, this case study focuses on Joseph Priestley's experiments and interpretation of combustion. A stage in-between what Friedrich Steinle (2002, 2005) calls "exploratory experimentation" and robust theory, I argue that analogy encouraged research to substantiate why the likenesses should outweigh the differences (or vice versa) when evaluating results and designing experiments. I contend that this methodological approach is especially evident in Joseph Priestley's research and helps to resolve a longstanding tension in our understanding of his chemistry, namely his dogged adherence to phlogiston theory.

Benjamin Franklin (1751), Priestley's mentor in electrical research, probably made the most famous analogical argument in the history of physics, namely that clouds produce lightning in the same manner as an electrostatic generator or, as Franklin would have called it, a friction machine. He was not alone in arguing that there existed likenesses between natural and laboratory-created systems, analogs that not only promoted scientific research, but also helped to underpin the epistemic value of experiment. As Alan Shapiro (1995, 43) has shown: "The belief in the 'analogy of nature', or that 'nature is ever consonant to herself', served as a guiding maxim throughout [Isaac] Newton's career." The Comte de Buffon, an influential French naturalist and director of the Royal Gardens, argued "that if 'experience is the foundation of all our physical and moral knowledge, analogy is its first instrument.'" (Riskin 2002, 95) Thomas Young (1971, 15), in a series of physics lectures, also emphasized its importance: "That like causes produce like effects, or, that in similar circumstances similar causes ensue, is the most general and important law of nature; it is the foundation of all analogical reasoning, and is collected from constant experience."

Like his contemporaries, Joseph Priestley also stressed the importance of analogical reasoning in the design and evaluation of experimental stratagems in electrical and chemical research. Although his publication— History and Present State of Electricity (1767)— was widely read and cited, few historians take Priestley's electrical research seriously or consider how it affected his chemical studies. A detailed analysis of his electrical and chemical research, however, shows that his electrical work informed his chemical studies in significant ways. Because heat and electricity produced common effects – e.g. exposing air to a spark or flame caused similar changes in its composition, volume, and toxicity – Priestley argued that electricity and heat were related substances. I argue that his identification of phlogiston with electrical fluid affected how he received his contemporaries' chemical studies, especially Antoine Lavoisier's theory of heat.

Accounts of the chemical revolution are diverse and sometimes at odds with one another. Key elements of this transformation include, but are not limited to, the overthrow of phlogiston theory, a common eighteenth-century explanation for inflammability, and new emphasis on measurement, especially the weight and volume of chemical reactants and products. As John Heilbron (2000) notes, there are three main lines of argumentation: the external— Lavoisier and others importing quantitative methods from physics construct a revolution in chemistry; the internal—chemists' methods underwent a dramatic shift in a short period of time, changing the theory and practice of chemistry from within; and the revisionist– there was no revolution per se, but rather through a series of slow and successive modifications chemistry was transformed.

Within this literature, Priestley has a mixed legacy. He was (and is) celebrated for having isolated vital air or dephlogisticated air (oxygen) and for showing it was necessary to animal respiration. Yet, because he vocally opposed French chemists' attempts to develop a new chemical nomenclature and Lavoisier's theory of heat, he was (and is) disparaged for defending phlogiston and for not "seeing" the theoretical implications of his own chemical research, i.e. oxygen was absorbed during combustion. There is an incongruity between these different depictions of Priestley. Roughly put, it is difficult to reconcile how a creative experimentalist could also be, as his biographer Robert Schofield (2004, 193) writes, "a bumbler".

Although this presentation deals with Priestley's chemistry, I make no attempt to enter into this larger debate of whether or not there was a chemical revolution. Rather, I am interested in reassessing Priestley's defense of phlogiston in light of his electrical research and emphasis on analogical reasoning. It is a modest attempt to restore Priestley's work to the fold. I argue that his dogged defense of phlogiston—his explanation for thermal and, as I will show, electrical phenomena—stemmed from both his chemical and electrical research, which were inextricable. The questions he was trying to answer about chemical properties and behavior differed significantly from his contemporaries because he was considering a broader range of phenomena that included not only thermal effects, but also electrical phenomena. Analyzing his chemical experiments in light of his electrical research and commitment to analogy helps to clarify some of his seemingly contradictory statements regarding chemical processes; therefore, providing a better understanding of his theory and practice. By taking an integrated historical and philosophical approach to his research, I demonstrate that Priestley was less a foil to the progressive French chemistry than a would-be synthesizer in a time of increasing specialization.

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